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# Planning for rural energy system: part I

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## Abstract

This paper presents a two pronged approach for identifying the important parameters which control the economy in the rural system, particularly in relation with energy inputs and outputs leading to a comprehensive analysis of the energy scene in the rural system. On one hand, related literature was collected, and segregated into various categories like household, agriculture, application of technologies and their impacts in the rural system, energy planning, etc. and are examined. On the other hand, a systematic methodology for primary survey of ground level realities about rural energy consumption taking into account the most significant parameters that influence the pattern and intensity of energy use has been employed. Multiple interactions in the rural system due to the several products having multiple uses have been taken into account. Details of the design of the sampling and the method of administering the survey along with brief account of some of the more salient results obtained from the survey have been presented. The study concludes by identifying several parameters which influence energy consumption in a rural economic system. This paper also discusses the relevance of surveys for realistic planning at micro level by drawing attention to the large discrepancies that account between statistics obtained from primary and secondary sources. © 2001 Elsevier Science Ltd. All rights reserved.

*Keywords:* Micro level planning; Rural energy planning; Rural energy; Rural energy consumption; Energy interaction; Sampling design; Community development; Block

## Contents



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## 1. Introduction

In India, application of science and technology at the village level, which started, in a small way with the advent of the planning era, has found an increasing role since late 1960s. Application of improved technologies led to changes in cropping pattern through induction of improved varieties, use of inorganic fertilizers, intensive irrigation, and concomitant changes in the pattern of energy inputs to a large extent. These changes led to not only improvement of the economy but also increase the disparities within the rural system.

The state of the economic development of any country can be assessed from the pattern and quantity of its energy consumption. Energy demand in India also is increasing with the pace of development and population growth. However, the quantitative energy consumption and its pattern reveal a stark contrast between the rural system and the urban system. The urban system largely depends on commercial

energy sources, while the rural system is primarily dependant on non-commercial energy sources like fuelwood, animal dung, and crop residues. But these energy resources are becoming increasingly scarce over the years, and if this trend continues, the shortage of fuelwood alone would to be around 190 Million $m^3$ by 2000 A.D., and the estimated deficit in fodder availability would be about 160 million tons [1]. These deficits can be met either through import of energy, or by developing new energy sources within the country. However, like most of the developing countries, the policy objectives for India are also severely constrained due to high energy prices and an adverse balance of payment. Moreover, factors like the adverse environmental impacts of deforestation, and denudation because of twin pressures of increasing population and dwindling resources also make micro level energy planning an area of critical importance.

This study aims to identify the more significant parameters for rural energy planning through a two pronged approach. They are:

1. a careful perusal of the relevant literature; and
2. site specific field study.

Several aspects covering major features of energy scenarios in Rural India have seen intensive research by various investigators [1–3,7–10,13–16,20–24,27,31–43,46,48–57,59,63], and may be broadly classified into several categories. They are:

1. household energy consumption;
2. energy consumption in agriculture;
3. energy interactions in the rural systems;
4. assessing economic feasibility of technologies in the rural systems;
5. impact of technology on rural systems; and
6. rural energy planning at the micro level.

This paper attempts a review of the literature in each category, and draws general conclusions about the energy scene in Rural India on one hand, and evolves a scientific methodology for executing systematic rural energy survey at the micro level.

### *1.1. Household energy consumption*

To assess the rural household commercial as well as non-commercial energy consumption for cooking, space heating and lighting, field studies have been conducted [20,25–28,56]. The per capita annual fuelwood consumption for cooking varies in different regions as shown in Fig. 1. Energy consumption also varies widely with occupation, income level, and size of land holding [1,5,6,8,20,25,26,28,37,43–47,52]. The increase in energy consumption in cooking with increase in income as shown in Fig. 2. Energy consumption is also found to increase with increase in size of farms [1,5,6,25,26,28,37,43,45–47,52]. Furthermore, large farmers consumed a larger quantity of energy compared to those in non-farm categories like landless labourers, small businessmen, and government and non-government employees [1,52]. It has

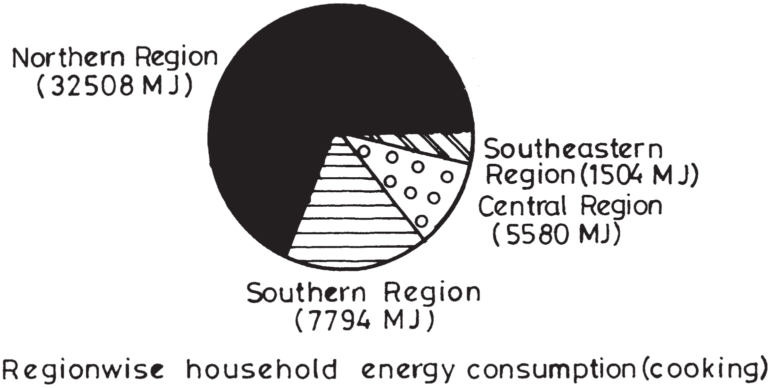


Fig. 1. Energy consumption (units in MJ/annum).

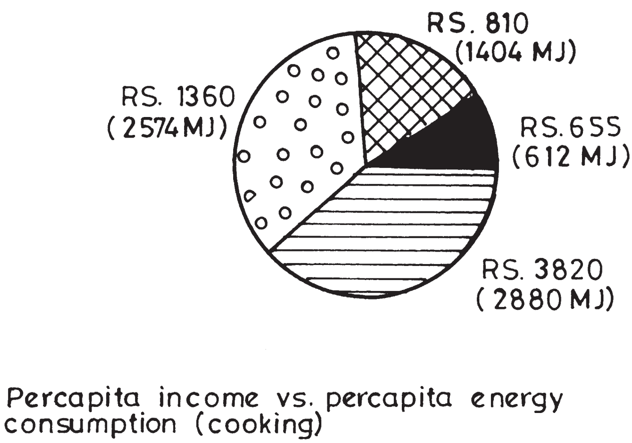


Fig. 2. Income vs energy consumption (units in MJ).

been observed that for rural communities, commercial energy meets only 5–10% of the total domestic needs, the rest being met through non-commercial energy sources [5,8,9,20,25,26,28,37,46,47,52,62]. Higher income households consume larger quantity of commercial energy, whereas, low-income households consume a larger quantity of non-commercial energy [1,8,20,46], also larger farms consume a larger quantity of commercial energy, whereas, the marginal farms consume a larger quantity of non-commercial energy [5,9,26,28,37,46,47,52]. Fuelwood collection is a predominant feature of the rural energy scene. Lower income households have little area under homestead lands, and have to perforce engage in fuelwood collection for meeting their cooking energy needs [20,46,52]. The average distance covered for fuelwood collection depends on its availability and varies from 1 km in the northern region to 3 km in the southern region [1]. Bonded and landless labourers spent considerable time and effort in fuelwood collection, but may also sell surplus fuel-

wood to others [1]. Commercial energy in the form of kerosene, and electricity is mainly used for lighting in the villages. Higher income households consumed a larger quantity of electricity for lighting, whereas, lower income households consumed a larger quantity of kerosene for lighting [1,8,20,46] as illustrated in Fig. 3. It is interesting to note that in some areas of Northern India, fuelwood is also used for lighting accounting for 2% of the total fuelwood consumption in the year 1987 [20]. Labour requirement for household activities like cooking, fetching water, fuelwood collection, dung cake preparation, and cleaning utensils has been estimated to vary from 5.5 to 16.50 man-hours per day per household [25,28,60] with the female members of the households contributing nearly 80% of the requirement [1,8].

### *1.2. Energy consumption in agriculture*

Energy consumption in agriculture depends on the type of crop and the agro-climatic conditions. In fact, the choice of crops for cultivation in an area is guided by the agro-climatic conditions, irrigation resources of the region, and the availability of different commercial and non-commercial energy sources. A number of studies have been conducted for assessing agricultural energy consumption for different geographical situations and agro-climatic conditions, different types of crops cultivation in different sizes of farms [1,6,9,11,14,15,25,27,28,37,40–42,46,49,53,57,58,60]. A positive relationship has been found between energy consumption (particularly commercial energy consumption) and agricultural production. [6,9,14,23,25,28,40,42,47,53,58,60]. Energy consumption in agriculture increases with increase in the size of farms [1,25,27,28,57,60], irrigation accounts for the largest share [9,11,14,37,40,41,47,57]. It has also been observed that though farmyard manure is locally available, its application is gradually decreasing resulting in a consequent shift to an increased application of inorganic fertilizer at farm level for

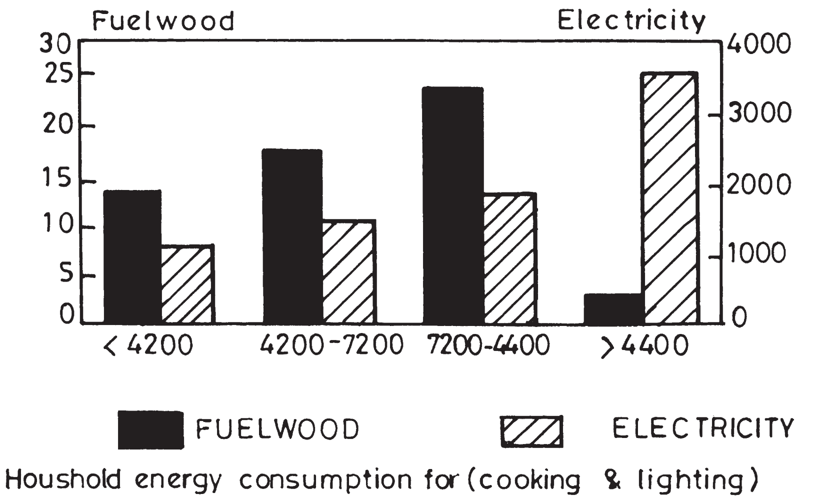


Fig. 3. Income vs energy consumption (units in MJ).

improving yield and productivity is taking place [49]. By and large, larger farms use a larger quantity of chemical fertilizers, whereas, the marginal farms use a larger quantity of farmyard manure [1,46]. Energy consumption in Indian agriculture in 1960–61 was 114.8 peta calories and was estimated to grow to 490.50 peta calories by the year 2000 [15].

### *1.3. Energy interactions*

A rural system incorporates several interacting subsystems, such as, household, agriculture, livestock, rural industries and rural transportation, and functions as an integral whole. These subsystems are inter-linked and interdependent on each other in several ways. In a given rural system, the output of a subsystem, in general, has a multiple usages, and thus may form the input to one or more subsystems. For example, the subsystems, household, obtains energy from households, agriculture, and livestock in the form of human labour, animal power, food and non-food, while supplying energy input in the form of human labour to all other subsystems. The subsystem, agriculture obtains energy from different rural subsystems, such as, household, livestock and rural transport, in the form of human labour, animal power, and farmyard manure. It receives energy from outside the system in the form of electricity, diesel, and chemical fertilizers, but also produces energy in the form of food, non-food, crop residues, fodder, timber, logs fuelwood, etc. which have multitude usages, and thus supplies energy inputs to other subsystems. The subsystem, livestock, obtains energy from household, agriculture, transport, and from itself in the form of human labour, animal power, crop residues, fodder, feed, etc., while it provides energy inputs to other subsystems, such as, households, agriculture, rural industries, and transport. It is interesting to note that although, the adoption of high yielding varieties leads to an increase in food grain production, it results in a reduction in the production of crop residues. This feature adversely affects the small farmers due to shortage of fodder and fuel. Increased population growth increases the demand for food and fuel, but higher population density would decrease the per unit share of land area, and animals and biological resources. Consequently, rural areas face an acute shortage of food, fuel and fertilizer due to increase in population [38,39].

### *1.4. Assessing the economic feasibility of technologies*

For assessing the economic feasibility of different technologies employed in the rural areas, the alternatives like bullock power and tractors at the farm level, use of electric and diesel engine pump sets for lifting ground water, biogas and solar cooker technologies for cooking, and kerosene and electricity for lighting at the household level, have to be considered. Discounted cash flow technique was used for assessing the economic feasibility of different technologies at the households and farm levels [2,3,6,11,12,14,31,36,37,48,50,54,55,57,59,63]. Use of tractors is preferred over bullock power for very large size of operational holdings [6,11,14,36,50,57]; and vice versa for small farms [31]. The performance of diesel and electric pump sets for

irrigation has been assessed in terms of their operational costs for discharging a particular volume of water in a year, and electric pump sets have been found to be more feasible [14,32,37]. Application of biogas technology at the households is economically feasible, technically viable and socially acceptable in the rural areas [2,3,35,48,54,55,63]. Application of solar cooker at the household level is also economically feasible [12,36,59].

### *1.5. Impact of technology*

Application of new technologies in the agricultural sector in India become more intensive after the late 1960s. Agricultural production in the year 1985 had reached 178 million tons (an increase of >50% over a period of 15 years) due to a chain of technological innovations at farm level. These include the introduction of improved varieties, better irrigation facilities and increased application of commercial energy including chemical fertilizers and pesticides [41]. Energy consumption in Indian agricultural system increased from 114.80 peta calories in 1960–61 to 131.7 peta calories in 1980–81; mainly attributed to increase in irrigated area, application of inorganic fertilizers, and pesticides [15]. The share of energy consumption in agriculture of India's total energy consumption has also increased from a mere 1% in 1953–54 to 6% in 1978–79 [16]. In the year 1951–52, the total net sown area in India was only 40.49% of the total geographical area, and out of that only 17.39% was covered by irrigation. By the year 1984–85, the net sown area had increased to 57.48% of the total geographical area, and out of that 30.72% area was covered by irrigation. This became possible due to the introduction of a larger number of electric and diesel pump sets at the farm level, and the construction of multipurpose reservoirs, which are also used for irrigation. Adoption of tractors, bullock powered ploughs, electric and diesel pump sets, at the micro level under different agro-climatic conditions have been analysed [10,12,43,58]. It has been observed that in some regions use of tractors led to an increased consumption of energy per hectare of land compared to bullock operated farms due to bulk use of mechanical energy for tillage, irrigation and threshing operations [43,58]; in some regions, bullock operated farms have been found to consume more energy per hectare of land in comparison to tractor operated farms [10,12,50,58]. Mixed farms, where both bullock and tractor technologies are used together, consume a smaller quantity of energy compared to the farms which make exclusive use of either bullock or tractor power [10]. Energy consumption through the use of improved implements at the farm level save 28.90, 44.00, 40.40% in paddy, wheat, and fodder cultivation, respectively [10]. Intensive and non-intensive cultivation practices for wheat crop have been examined for assessing the efficiency of chemical fertilizers [31]. In 1984, an intensive cultivation of wheat, yield of crop and straw were at 3960 and 2700 kg/ha, respectively, with an energy consumption of 23 353.70 MJ/ha, in the corresponding figure for non-intensive cultivation being 1200 and 2000 kg/ha and 6338 MJ [33]. Application of biogas technology at the household level for cooking and lighting results in a decreased consumption of both commercial and non-commercial energy forms. The nutrient content of the slurry for fertilizer application was found to increase in comparison with fresh dung

[3,7,10,21,24]. Adoption of solar cookers at the household level for cooking can lead to a substantial decrease in fuelwood consumption. Solar cookers can save upto 75% of cooking energy in regions, where rice is the staple diet [29]. Adoption of improved stoves having a thermal efficiency of over 40% as compared to the conventional devices having a thermal efficiency of about 15%. Use of the improved stoves would not only reduce fuelwood consumption, but would also save cooking time. Since the improved stoves possess a chimney, smoke and soot are minimized, resulting in a marked reduction in air pollution with consequent health benefits for women folk [4,13,15,51,62].

### *1.6. Rural energy planning at the micro level*

Various authors have worked on rural energy planning at the micro level by taking into account factors like population growth and agricultural operations, and have estimated the gap between the demand and supply of energy and made recommendations based on steps to be taken for closing this energy gap [43,46]. These include effective introduction of biogas technology, generation of electricity from biomass and biogas, expansion of electricity consumption for lighting, introduction of improved kerosene stoves, introduction of improved cooking stoves, etc. [43,46]. Minimization of the overall energy costs, minimization of uses of non-local resources and maximization of the efficiency of overall usage has been recommended [30]. Goal programming technique has been used in order to achieve the objectives in respect of energy for cooking, and lighting [27]. Sensitivity analyses were also carried out by changing some parameters, such as, introduction of improved stoves in the system, changing the cost of electricity, and introduction of biogas. It was seen that in electrified village, use of electrical energy for lighting, and use of fuelwood for cooking with adoption of improved stoves and reserving the biogas potential for other uses constituted the best option [30]. In an non-electrified village, use of biogas for lighting, and the use of fuelwood with improved stoves for cooking appears to be the best option [30].

In urban areas, the per capita consumption of electrical energy is about ten times, and that of oil derived energy about double that in the rural areas. Fuelwood meets 68.5% of the total energy use in rural areas and 45.5% in the urban areas. The share of commercial energy is 49% of the total energy consumption in urban areas as compared to only 20% for rural areas [17]. In view of these basic differences, rural energy planning must involve an extension of the micro level energy scene as a whole, along with in depth study of its subsystems like households, agriculture, livestock, and rural transportation.

## 2. Need for a household survey

Energy consumption in the study area depends on several spatial, seasonal, socio-economic, and techno-economic factors. The availability of resources varies from area to area, season to season, household to household, and so on. Most of the

cooking energy resources are acquired through fuelwood and biomass collection. While crop residues and other biological residues are collected during the harvest and summer seasons, cooking fuel is purchased during the monsoon season. Thus, the domestic energy consumption is much higher during the monsoon and winter seasons as compared with the summer season. The lower income households collect a larger fraction of non-commercial energy resources, while the higher income households purchase a larger fraction of commercial energy (mainly in terms of liquefied petroleum gas, kerosene and electricity) and also use a smaller fraction of non-commercial energy resources (like fuelwood, twigs, logs, etc.) even from their own homestead and farm lands. Adoption of improved technology is also not popular amongst the lower income households due to poverty and other social constraints, whereas, a larger fraction of the higher income households use devices like energy efficient stoves. In order to quantify these characteristic features of the rural energy scene, a household survey was considered to be essential. The information collected through the survey not only leads to an understanding of the factors that influence variations in the energy use pattern, but also became instrumental in assigning priorities for alternative uses of resources for energy and non-energy applications.

## 3. Sampling design

Kanyakumari district (Fig. 4), one of the industrially backward districts in India, was selected for the purpose of the investigation. Relevant data was collected through an extensive field level survey for supplementing the data available from census and other sources. The study area can be divided into three agro-climatic regions as shown in Fig. 5. Three community development blocks were selected, one on the basis of maximum area under irrigation; the next on the basis of the maximum area unirrigated; and the last for possessing the largest size of forest area with urban linkage. Details of the community development blocks and the selected community development blocks are shown in Fig. 6.

### *3.1. Selection of revenue villages*

Each community development block in the study area comprises 9–12 revenue villages. The revenue villages in the three sample blocks were arranged in ascending order of forest, irrigated and unirrigated areas for sampling purpose. From each block, a revenue village having the largest area in terms of their respective statistical attribute was selected. The selected revenue villages is shown in Fig. 7.

### *3.2. Selection of sample villages*

Each revenue village comprises 10–12 villages. Six villages were selected by picking two villages at random from each sample revenue village. Selected revenue villages and the corresponding selected sample villages are listed in Table 1.

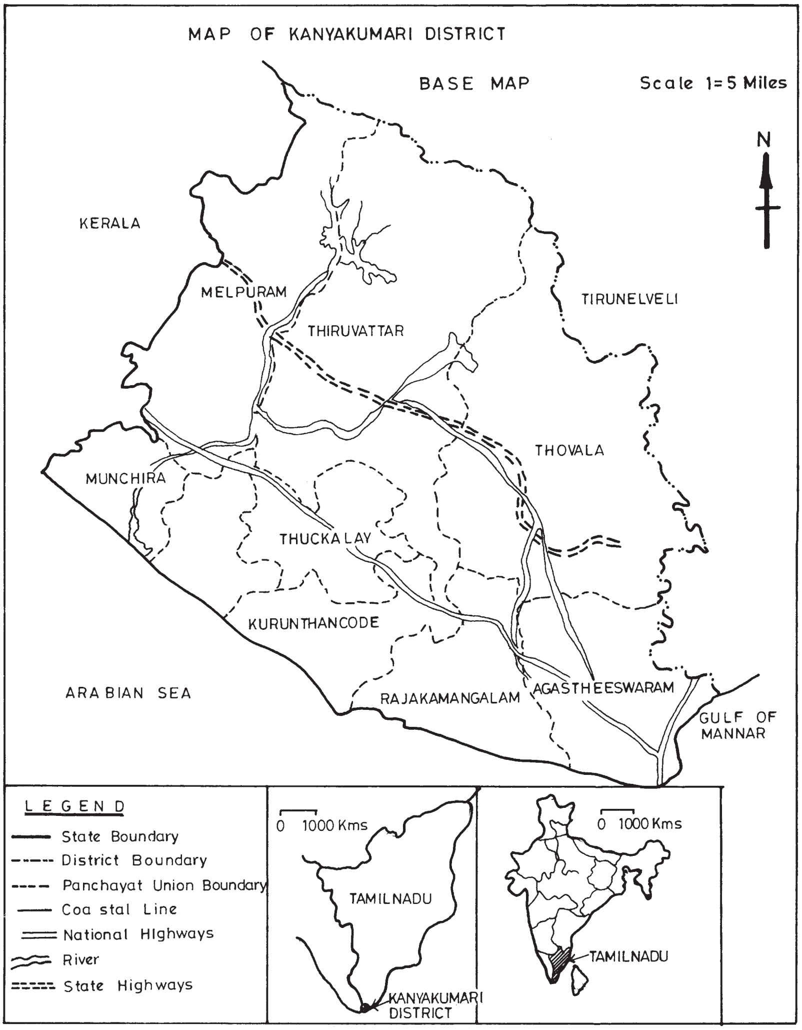


Fig. 4. Description of study area.

### 3.3. The house-listing schedule

A house-listing schedule was developed, and administered to all households of each sample village. The house-listing schedule covered all households in the selected villages and provided detailed information like the size of the households, the occupation of the members, the size of operational land holdings, etc.

While conducting the house-listing survey through his close interaction with village heads and the villagers themselves, the author came to the conclusion that factors like cropping pattern, particularly in respect of the ratio of the areas covered by field crops and plantation crops, percentage of land with irrigation facilities and the mode

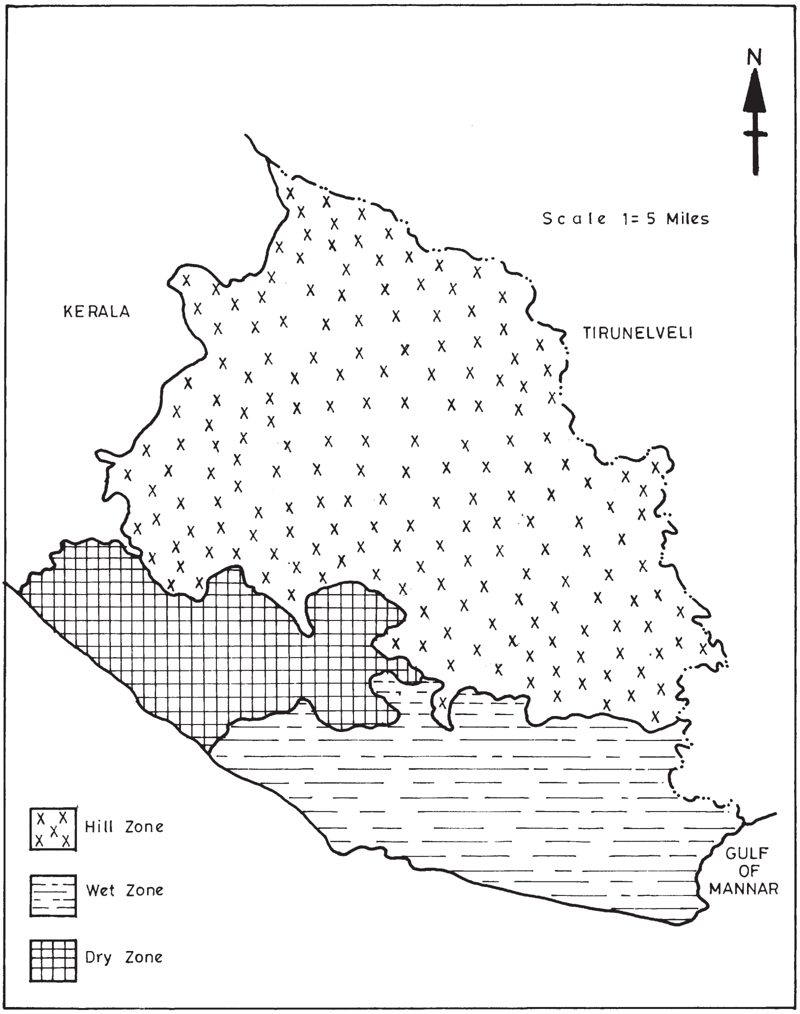


Fig. 5. Description of agro-climatic zones.

of irrigation, illumination, etc., which have important bearing on production and consumption of commodities and energy at the village level, are greatly influenced by the size of land holding of a particular household. Consequently, the households under the study were divided into four categories classified on the basis of the area of their operational holding.

The households were arranged in the ascending order of the size of their operational holdings for stratification in four categories of farms: marginal; small; medium; and large farms.[1] This process also identified the landless agricultural labourers and other non-agricultural personnel in the village as presented in Tables 2 and 3.

[1] Size of farms are classified on the basis of land holdings, that is, marginal farms is up to 1 ha; small farms=1.01–2.00 ha; medium farm=2.01–4.00 ha; and large farm≥4.01 ha.

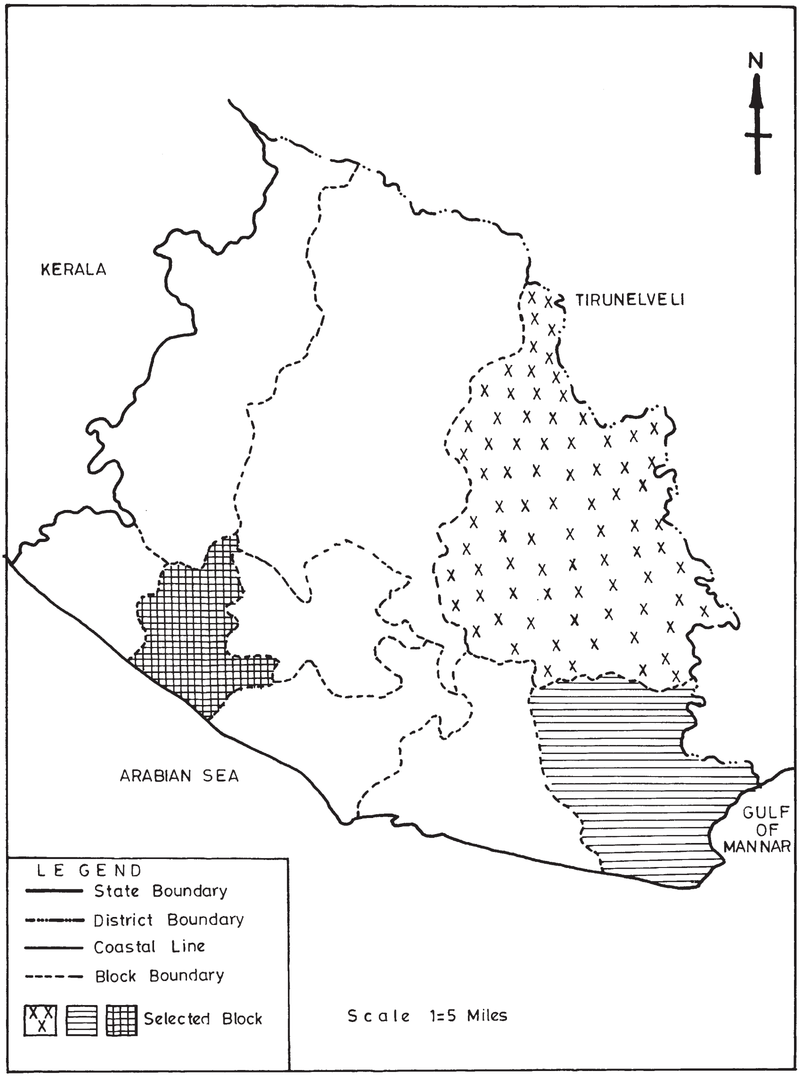


Fig. 6. Description of the selected community development blocks.

### 3.4. Selection of sample households

Next, the Households in each farm size category were listed in an alphabetical order of the names of the head of the households. Since four of the six selected villages did not have any household falling in the large farm category, a total of 20 (4×3+2×4) such lists were prepared, and 40–45 households were chosen from each village using a systematic random sampling method. The sample ratio, *K* (defined as the ratio *N*/*n*, where, *N* and *n* represent the total number of households and the

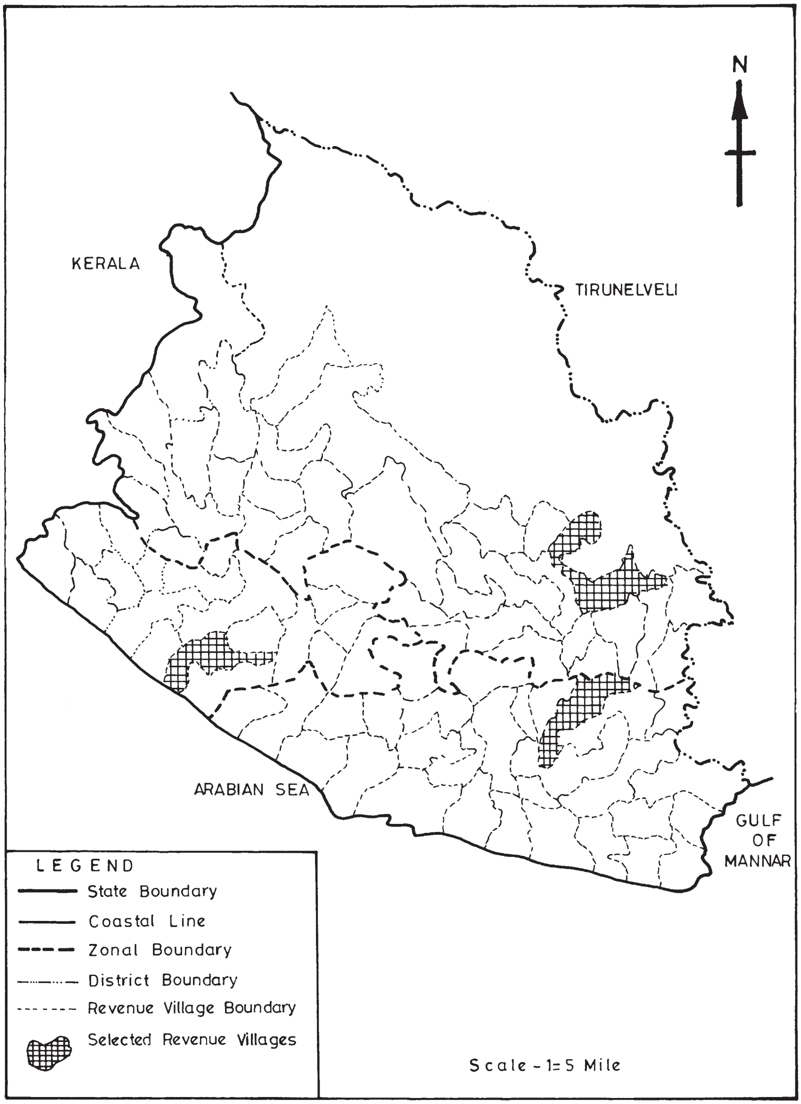


Fig. 7. Description of the selected revenue villages.

sample size, respectively) varied from 5.62, 5.68, 3.17, 3.11, 2.15, and 2.18 for sample villages Nos 1–6, respectively. The overall average $K$ was 3.68. A total of 251 sample households were selected on the basis of this method for conducting the detailed survey at the household level. Farm size distribution of total households and the sample households for this study are presented in Tables 4 and 5, respectively.

Table 1
Revenue villages and villages

| Sl. No. | Name of the C.D. blocks | Names of the: | |
|---|---|---|---|
| | | revenue village | village |
| 1 | Thovalai | Ananthapuram | (a) Kattuputhoor<br>(b) Kadukarai |
| 2 | Agesteeswaram | Theroor | (a) Puthukiraman<br>(b) Kulesekaram Puthoor |
| 3 | Killiyur | Midalam | (a) Vadakankarai<br>(b) Karukupanai |

Table 2
Details of the sample villages

| Sl. No. | Name of the villages | L.C. No. | According to house-listing | | |
|---|---|---|---|---|---|
| | | | No. of farm houses | Population | Size of houses |
| 1 | Kattuputhoor | 6 | 253 | 1237 | 4.89 |
| 2 | Kadukarai | 6 | 227 | 1090 | 4.80 |
| 3 | Puthukiramam | 3 | 130 | 597 | 4.59 |
| 4 | Kuleskharam Puthoor | 3 | 140 | 657 | 4.69 |
| 5 | Vadakankarai | 23 | 86 | 376 | 4.37 |
| 6 | Karukupanai | 23 | 87 | 392 | 4.50 |

Table 3
Distribution of establishments in the sample villages

| Sl. No. | Name of the villages | Total No. of establishment | Churches temples, schools, shops, etc. | Households of landless agrilabors | Househlds of landed farmer | Total households |
|---|---|---|---|---|---|---|
| 1 | Kattuputhoor | 484 | 8 | 223 | 253 | 476 |
| 2 | Kadukarai | 478 | 8 | 243 | 227 | 470 |
| 3 | Puthukiramam | 169 | 12 | 27 | 130 | 157 |
| 4 | Kulesekharam Puthoor | 169 | 10 | 19 | 140 | 159 |
| 5 | Vadakankarai | 95 | 2 | 7 | 86 | 93 |
| 6 | Karukupanai | 111 | 7 | 17 | 87 | 104 |

Table 4
Size groupwise distribution of households in the sample villages[a]

| Sl. No. | Name of the villages | Size groups[a] | | | | Total households |
|---|---|---|---|---|---|---|
| | | 0–1.00 | 1.01–2.00 | 2.01–4.00 | 4.01–10.00 | |
| 1 | Kattuputhoor | 212 (83.79) | 24 (9.49) | 17 (6.72) | – | 253 (100.00) |
| 2 | Kadukarai | 167 (73.57) | 39 (17.18) | 21 (9.25) | – | 227 (100.00) |
| 3 | Puthukiramam | 104 (80.00) | 17 (13.08) | 7 (5.38) | 2 (1.54) | 130 (100.00) |
| 4 | Kulasekharam Puthoor | 90 (64.29) | 37 (26.43) | 9 (6.43) | 4 (2.85) | 140 (100.00) |
| 5 | Vadakankarai | 73 (84.88) | 13 (15.12) | – | – | 86 (100.00) |
| 6 | Karukupanai | 76 (87.36) | 7 (8.05) | 4 (4.59) | – | 87 (100.00) |

[a] Figures in parentheses indicate percentage of total.

Table 5
Sample households from the villages[a]

| Sl. No. | Size of farms (ha) | Name of the villages | | | | | |
|---|---|---|---|---|---|---|---|
| | | V.1 | V.2 | V.3 | V.4 | V.5 | V.6 |
| 1 | Below 1.00 | 33 (31.73) | 29 (32.22) | 34 (46.57) | 37 (48.68) | 21 (12.57) | 32 (15.09) |
| 2 | 1.01-2.00 | 5 (29.41) | 12 (32.43) | 6 (46.15) | 2 (28.57) | 13 (33.33) | 9 (37.50) |
| 3 | 2.01–4.00 | 2 (28.57) | 3 (33.33) | – | 1 (25.00) | 6 (28.57) | 4 (23.52) |
| 4 | 4.01–10.00 | 1 (50.00) | 1 (50.00) | – | – | – | – |

[a] Figures in parentheses indicate percentage to total households in the representative columns of the house listings. V.1, Puthukiramam; V.2, Kulasekharam Puthoor; V.3, Vadakankarai; V.4, Karukupanai; V.5, Kadukarai; V.6, Kattuputhoor.

## 4. Other schedules

For collecting detailed household level information a household schedule was developed and pretested in the study area. In addition schedules for gathering necessary information from the officials of the district and community development block levels were also developed. These schedules are described below.

### *4.1. Household schedule*

The household schedule was specifically designed for collecting the following information:

1. Physical, and socio-economic characteristics of the households, such as, size of family, operational holdings, area under different sources of irrigation, normal activities, occupation, the number of different types of livestock availability, value of farm assets, cropping pattern, crops production, details of income, expenditure, investment, area under energy plantation and its production, literacy and educational level, caste, religion, topography, etc.
2. Domestic energy requirements for cooking, lighting, and other household activities like fetching water, shopping and biomass collection.
3. Energy consumption in agriculture and allied activities, like livestock rearing, and poultry farming.
4. Energy consumption in post harvest operations, and processing.
5. Energy consumption in transportation.
6. Application of energy efficient technology.

### *4.2. The district level schedule*

The district level schedule was employed for collecting data concerning the energy scene of the district. The contact persons chosen for this survey were officials directly involved in development related administration at the district level. Thus, the Project Officer of the District Rural Development Agency, assistant directors of different departments like statistics, animal husbandry, forestry, fisheries, agriculture, horticulture, and khadi and village industries were given this schedule for collecting relevant data for about their respective areas. In addition, project officers directly involved in energy schemes were also contacted for gathering information.

### *4.3. The community development block level schedule*

The community development block level schedule was used for collecting information on topography, sources of and area under irrigation, forest area, etc. at the revenue village level. Block development officers and village development officers, and officials directly involved in development related administration and programme implementation at the village level were contacted for the completion of this schedule. Fig. 8 shows an over view of the different levels covered in the survey methodology and identifies the sources of information and the personnel responsible for giving relevant information for each level.

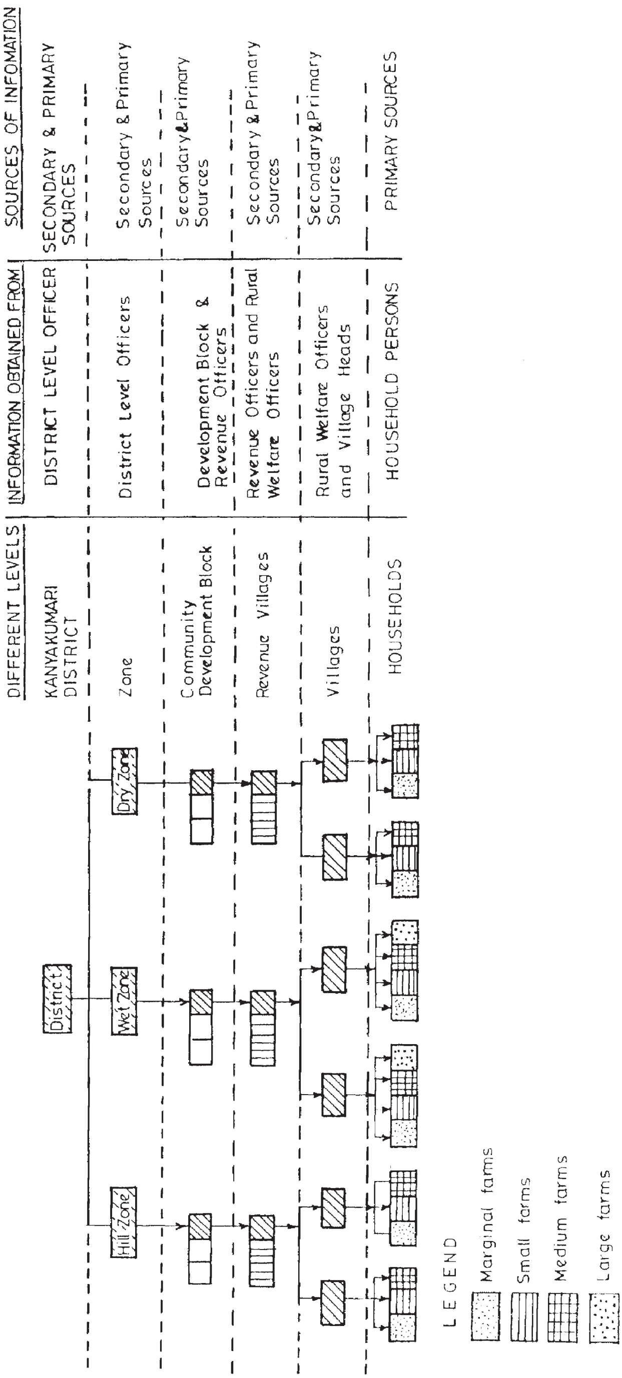
DIFFERENT LEVELS
INFORMATION OBTAINED FROM
SOURCES OF INFOMATION
KANYAKUMARI DISTRICT
DISTRICT LEVEL OFFICER
SECONDARY & PRIMARY SOURCES
Zone
District Level Officers
Secondary & Primary Sources
Community Development Block
Development Block & Revenue Officers
Secondary & Primary Sources
Revenue Villages
Revenue Officers and Rural Welfare Officers
Secondary & Primary Sources
Villages
Rural Welfare Officers and Village Heads
Secondary & Primary Sources
HOUSEHOLDS
HOUSEHOLD PERSONS
PRIMARY SOURCES
District
Hill Zone
Wet Zone
Dry Zone
LEGEND
Marginal farms
Small farms
Medium farms
Large farms

Fig. 8.

## 5. Method of administering the survey at the household level

The survey was conducted in the agricultural year 1989–90, which is referred to as the base year in this paper.

Initially, the author contacted the rural welfare officers at the community development block level to seek assistance in conducting the survey, and explained the objectives of the survey. The rural welfare officers assisted the author in identifying the sample villages in accordance with the procedure described earlier. The author had detailed discussion about the typical characteristics of the villagers with the rural welfare officers and was given considerable and valuable insight about the attitudes of the villagers towards such activities.

The rural welfare officer introduced the author to the village heads of the respective villages, and also helped him in explaining the objectives of the survey, and in obtaining permission for conducting the survey in the villages. Each village head in turn, took the author to various households and explained the objectives of the survey to the householders, and helped the author in conducting the survey.

At the outset, the author conducted the house-listing survey covering all the households in the sample villages. The author compiled the house-listing survey data for the villages, and cross-checked it with the village head for removing any bias in the information. The information yielded by the house-listing survey led to the identification of the households for conducting the detailed household survey.

The author also conducted a pretesting survey in some of the identified households for finalising the schedule. For this twelve households from different groups of land holding size were identified. The author conducted the pretesting survey with the help of the respective village heads.

For conducting the final survey at the household level, the author approached the households directly. The author had prolonged interaction with the members of the households after obtaining prior appointments from the respondents. The non-working hours of the villagers were preferred for conducting the survey. The heads of the households were considered as respondents for the purpose of the survey. Only in a few cases, when the head of a household was not available for interview, the next senior-most member of the household was interviewed. The author stayed in the villages from inception to completion of the survey. Since the author himself carried out the household survey while staying in the villages, he could gain considerable insight in the habits, preferences, aspirations and life styles of the people of the target area, and thus was able to draw some conclusions based on his own observations.

## 6. Analytical procedure

After compilation, the data were checked for completeness and correctness, and errors or bias in the returns were eliminated by cross checking, and subsequently, carefully transferred into code sheets, and to a computer for analysis. The Statistical Package for Social Scientists (SPSS) software was used for analysis.

## 7. Significance of the survey data

Most of the secondary data that were made available to the author at the time of this study (1989) for the district was based on the census for 1981. However, a part of the data which is documented year-wise by several concerned agencies, like the Department of Statistics and Survey, the Department of Agriculture, and the District Administration, is compiled over a period of several years before the year of publication by the concerned officials. Therefore, it is evident that the published data has an inherent skew in it, making it impossible to have an objective look at the rural system by relying only on the secondary data. Furthermore, data regarding several aspects having an important bearing on rural energy planning are not readily available in the published statistics. Hence, the author conducted the household survey by using pretested multi-stage schedules for the present investigation. This survey was conducted in 1989, which is considered to be the base year for this study.

The available secondary data, and the survey data (primary household survey data), are compared in Table 6, and the percentage variation of the secondary data with respect to the survey data is also shown. In some cases secondary data was not found to adequately reflect the ground reality. For example, the per capita cooking energy consumption in rural Tamil Nadu was 1732 MJ per year as per the secondary sources published in 1987 [18], was estimated to be 4733 MJ per year as per the survey data collected in 1989, and it was 5895 MJ per year as per recently published data (1992) [61]. Thus, the survey data and the recently published data were seen to be in reasonable agreement. It may also be noted that the values of several variables like density of livestock population, land under usage, ratio of irrigated area to total area, ratio of area under crop to total area, and cropping intensity have been taken for the district as a whole from the compiled reports of secondary data [19], while they were evaluated very closely for the rural household levels in the survey conducted by the author. Therefore, for some of these variables a large discrepancy between the secondary data and based on the primary survey was noted, and the survey data was taken to be a better representative of the rural system.

## 8. Conclusion

This paper reviewed literature pertaining to rural energy systems in India. An examination of the categories reveals the more significant parameters which are relevant for each category and are mentioned more frequently in the literature. The formulation of a micro level plan must finally be based on systematic compilation of the corresponding statistics about the target area. This study led to the development of an appropriate framework for micro level surveys by taking the more significant parameters into account through the collection of primary level data relation to energy demand and supply in a rural system. The development of schedules of the survey was based on the perusal of the literature for identifying the most frequently employed indicators. Several other parameters of local significance were also incorporated through close interaction with personal or officials of the district. Community

Table 6
Significant changes between the secondary data and the survey data

| Sl. No. | Particulars | Units | Secondary data | Survey data | Percentage difference[a] |
|---|---|---|---|---|---|
| 1 | Density of rural population | Nos | 718 | 621 | −15.62 |
| 2 | Literacy of rural population | % | 61.80 | 87.92 | +26.12 |
| 3 | Density of livestock population | Nos | 120.00 | 434.00 | +72.35 |
| 4 | Land under use | % | 65.95 | 97.97 | +32.00 |
| 5 | Irrigation | | | | |
| 5.1 | Irrigated area to total area | % | 32.24 | 81.41 | +49.17 |
| 5.2 | Irrigation intensity | % | 157.09 | 200.00 | +42.91 |
| 6 | Crops | | | | |
| 6.1 | Area under crop to total area | % | 43.94 | 97.95 | +54.01 |
| 6.2 | Cropping intensity | % | 118.00 | 192.31 | +74.31 |
| 7. | Crop production | ton/ha | | | |
| 7.1 | Paddy | ton/ha | 3.39 | 2.96 | −14.52 |
| 7.2 | Tapioca | ton/ha | NA | 23.13 | – |
| 7.3 | Coconut | ton/ha | 1.58 | 2.44 | +54.43 |
| 7.4 | Tamarind | ton/ha. | NA | 3.57 | – |
| 8 | Fuelwood production/capita/annum | MJ | 147.00 | 362.00 | +59.39 |
| 9 | Energy consumption | | | | |
| 9.1 | Household energy consumption | | | | |
| 9.1.1 | Cooking/capita/annum | MJ | 1732.00 | 4733.00 | +63.40 |
| 9.1.2 | Lighting | | | | |
| 9.1.2.1 | Electricity/capita | KWh | 96.21 | 63.94 | −50.46 |
| 9.1.2.2 | Kerosene/capita | Lit | 5.85 | 1.30 | −350.00 |
| 9.2 | Agriculture | | | | |
| 9.2.1 | Nitrogenous | kg/ha | 70.91 | 83.47 | +15.05 |
| 9.2.2 | Phosphatic | kg/ha | 32.22 | 44.12 | +26.97 |
| 9.2.3 | Potassic | kg/ha | 40.12 | 55.37 | +27.54 |
| 10 | Energy consumption for land preparation | | | | |
| 10.1 | Human labour | Nos/ha | NA | 150.00 | – |
| 10.2 | Animal power | Nos/ha | NA | 38.00 | – |
| 11 | Energy consumption for irrigation | | | | |
| 11.1 | Human labour | Nos/ha | NA | 49.00 | |
| 12 | Human energy consumption for livestock rearing | | | | |
| 12.1 | Working/animal | Nos | NA | 45.62 | – |
| 12.2 | Milch/animal | Nos | NA | 91.25 | – |
| 12.3 | Others/animal | Nos | NA | 45.62 | – |
| 13 | Energy consumption for transporting a ton of goods for a Km. | | | | |
| 13.1 | Human | Nos | NA | 17.00 | – |
| 13.2 | Animal | Nos | NA | 8.00 | – |
| 14 | Inputs and outputs from cattle | | | | |
| 14.1 | Inputs | | | | |

(continued on next page)

Table 6 (*continued*)

| Sl. No. | Particulars | Units | Secondary data | Survey data | Percentage difference[a] |
|---|---|---|---|---|---|
| 14.1.1 | Digestible crude protein | Ton | | | |
| 14.1.1.1 | Working/cattle/year | Ton | NA | 0.05 | – |
| 14.1.1.2 | Milch/cattle/year | Ton | NA | 0.09 | – |
| 14.1.1.3 | Others/cattle/year | Ton | NA | 0.06 | – |
| 14.1.2 | Total digestible nutrients | Ton | NA | | |
| 14.1.2.1 | Working/cattle/year | Ton | NA | 1.23 | – |
| 14.1.2.. | Milch/cattle/year | Ton | NA | 1.29 | – |
| 14.1.2.3 | Others/cattle/year | Ton | NA | 1.20 | – |
| 14.2. | Outputs | | | | |
| 14.2.1 | Milk/milch cattle/year | K.Lit | NA | 0.81 | – |
| 14.2.2.1 | Working/cattle/year | Ton | 0.54 | 1.14 | +52.63 |
| 14.2.2.2 | Milch/cattle/year | Ton | 0.54 | 1.14 | +52.63 |
| 14.2.2.3 | Others/cattle/year | Ton | 0.54 | 0.57 | +5.06 |
| 14.2.3 | Dung collection | % | | | |
| 14.2.3.1 | Working | % | NA | 80.00 | – |
| 14.2.3.1 | Milch | % | NA | 90.00 | – |
| 14.2.3.3 | Others | % | NA | 90.00 | – |

[a] In the percentage calculation, the variation is cited on the basis of the value of the base year percentage (survey data)—the value of secondary data percentage. For example, land under use.

development block levels, the revenue village levels and with the heads of the villages and the villagers themselves were contacted for the present investigation. Some of the salient results have been presented and more detailed data collected with the same methodology will be presented in a subsequent paper.

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